論文内容の要旨

Atmospheric neutrino oscillation analysis with solar terms in Super-Kamiokande

(スーパーカミオカンデにおける
太陽ニュートリノ振動パラメータを考慮した大気ニュートリノ振動解析)

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The atmospheric neutrino data have been well explained in the two-flavor $\nu_\mu \leftrightarrow \nu_\tau$ oscillation scheme and the Δm^2_{23} and $\sin^2 2\theta_{23}$ parameters have been measured. No evidence of the atmospheric ν_e oscillation has been observed and the mixing angle θ_{13} is consistent with zero by the results of θ_{13} search experiments. On the other hand, thanks to the precise measurements by solar neutrino observations and the KamLAND experiment, the LMA-MSW solution of the solar neutrino problem is established and the mixing angle θ_{12} and mass difference Δm^2_{12} have been measured accurately.

If these 1-2 parameters are considered into the atmospheric neutrino oscillation analysis, the oscillation of low energy atmospheric ν_e might be observed even in case of zero-θ_{13}. The effect of the ν_e oscillation induced by the 1-2 parameters depends on the octant of θ_{23} ($\theta_{23} > 45°$ or $\theta_{23} < 45°$). Therefore the atmospheric neutrino oscillation analysis including the 1-2 parameters has a possibility to determine the octant of θ_{23} for the non-maximal $\sin^2 2\theta_{23}$. This information cannot be obtained by the standard $\nu_\mu \leftrightarrow \nu_\tau$ two-flavor oscillation analysis because the oscillation probability in that framework depends on $\sin^2 2\theta_{23}$, not on $\sin^2\theta_{23}$.

We have observed large number of atmospheric neutrino events in Super-Kamiokande. In this thesis, the atmospheric neutrino data from the Super-Kamiokande-I (1996-2001) and Super-Kamiokande-II (2003-2005) are summarized and used in the oscillation analysis. The analysis has been done in the two schemes, pure two-flavor $\nu_\mu \leftrightarrow \nu_\tau$ analysis and three-flavor analysis with the 2-3 and 1-2 parameters. There is no significant discrepancy of θ_{23} from 45°, though the effect of the 1-2 parameters is seen in the χ^2 distribution. The stronger constraint on $\sin^2\theta_{23}$ has been observed in the analysis with the 1-2 parameters. The 1σ arrowed region for $\sin^2\theta_{23}$ is $0.425 < \sin^2\theta_{23} < 0.582$, which is equivalent to $\sin^2 2\theta_{23} > 0.973$.